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STRUCTURAL DELINEATION WITH GEOPHYSICAL APPROACH IN PARTS OF EASTERN DARWAR CRATON

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ABSTRACT

The aim of a magnetic survey is to investigate subsurface geology on the basis of the anomalies in the earth's magnetic field resulting from the magnetic properties of the underlying rocks. Common causes of magnetic anomalies include dykes, faults and lava flows. The magnetic method involves the measurement of the earth's magnetic field intensity. Typically the total magnetic field is measured. Measurements of the horizontal or vertical component or horizontal gradient of the magnetic field may also be made.

Regional total magnetic observations were made over an area of approximately 6744 Sq Km with geologically and tectonically interesting in the eastern part of the Dharwar craton. Usually magnetic field data was displayed in the form of a contour map, but interpretation is often made on profiles. A modern technique is to plot the magnetic data as a colour image (red=high, blue=low and all the shades in between representing the values in between). From qualitative analysis various geological boundaries and tectonic features such as faults and shear zones were identified. Trend characteristics of magnetic lineaments were brought through the magnetic intensity, low pass filter map and tilt derivatives. Quantitative analysis of an area's total spectrum of magnetic responses can produce depth information.

Key words: Total Magnetic Intensity, Structures, Power Spectrum, Qualitative Analysis, Eastern Darwar Craton

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1. INTRODUCTION

The gravity and magnetic methods constitute major potential field methods for geophysical analysis. However, interpretation with these methods is an intricate process as potential fields are characterized by various ambiguities. To start with, the field observed at any point represents the summation of the response of all subsurface sources at varying depths detectable by the instrument employed. The general sequence of magnetic anomaly analysis consists of a

qualitative study of anomalies, quantitative interpretation and the subsequent translation of the latter to corresponding geology. For qualitative analysis, anomaly / gradient profiles / analytic signal amplitudes were examined in the light of known geology to understand the general disposition of the constituent formations. Subsequently, for quanitative analysis power spectrum of the area can produce depth information.

As variations in susceptibility are more marked than corresponding variations in densities (Mita Rajaram et al., 2001) the magnetic method is very useful for obtaining information on the faults, other tectonic features and magnetic linear features that contribute to the structural configuration of the region. The present work was motivated to obtain the structural configuration in the region.

2. GEOLOGY OF STUDY AREA

The area is lying at geologically and tectonically interest the geology of Kalwakurthy-Nalgonda area (Figure 1) northern bank of Krishna River forms a part of the Eastern Dharwar Craton which is recognized for its emplacement of numerous kimberlite and lamproite bodies. The area is occupied by rocks of the Peninsular Gneissic complex, which comprises granodiorite and granite. Figure.1 gives the geology of the study area and also layout map of magnetic observation indicates red line. The mutual field relationships supported that the Tonalite-Trondhjemite Gneiss (TTG) suite is the oldest among the three (Tonalite-Trondhjemite Gneiss,Tonalite-Granodiorite- undulating topography in the northern part of the district (Ramadass et al.,2016), whereas study area as gentle and rolling topography. Undulating physiographic of the northern part is caused by residual and denudational granitoid hills, stony waste, rocky slope, and cliffs. Most of the granite gneiss hills were bisected by NE-SW and NW-SE trending lineaments. The streams in the study region include Pedda Vagu, Devarakadra vagu, which are tributaries of River Krishna flowing towards southern direction. The drainage pattern varies from sub-dendritic, trellis, parallel and rectangular. Most of the low order stream occupied pre-existing joints and fractures of the granite-gneiss rocks.

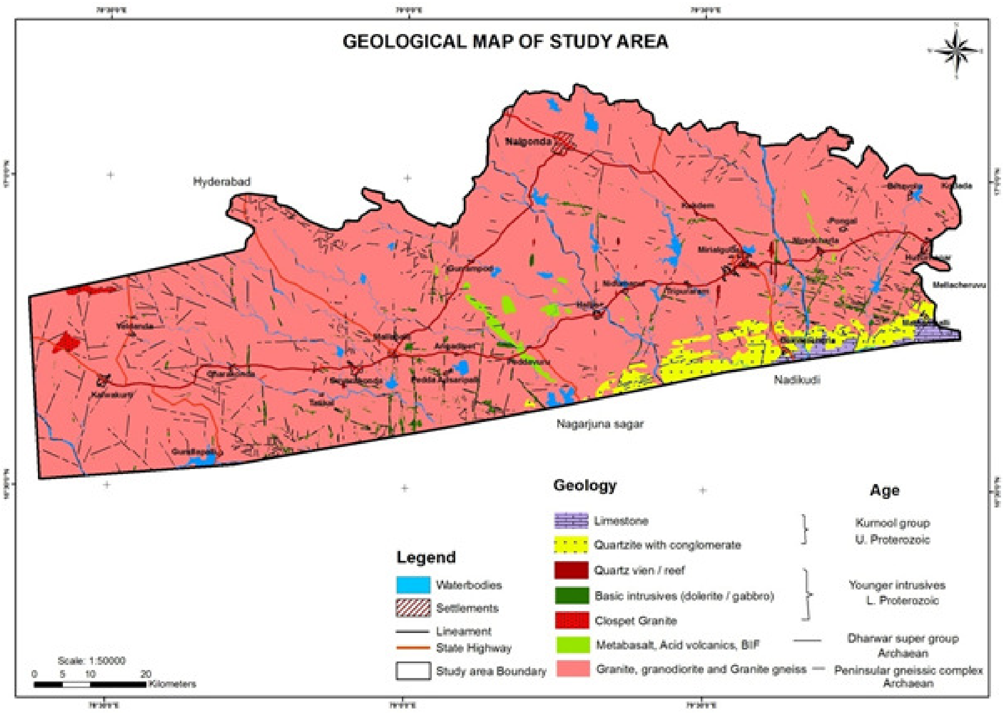


Figure 1 The geological map of the stud area (After GSI 2011).

The Dharwar super group are exposed as linear belts near Peddavura on the Hyderabad-Nagarjuna Sagar road. In the southern part of the district along the northern bank of Krishna river, the rocks of Achaean Peninsular Gneissic complex are unconformably overlain by sedimentary rocks of 1100-600 Ma, constituting the Cuddapah super group and Kurnool group. The Cuddapah super group in the district is predominantly made up of erinaceous and argillaceous sediments respectively, represented by quartzite and shale of Cumbum formation and Srisailam quartzite. The Kurnool group of rocks comprised calcareous sediments and quartzite, limestones (Sriramulu et al, 2016, Udayalaxmi et al., 2016) are exposed at the southeast margin of the traverse. The study area is represented by magmatic gneiss and ultramafic rocks. These are followed by metabasalts. Banded iron formation is interbedded with ultramafic flows and mafic dykes intrude the volcanic sequence.

3. MAGNETIC INVESTIGATIONS

The study area covers an area of 6744 sq. Km(geographic coordinates of 16°40'14.325"N, 78°29'29.107"E and 17°3'2.587"N, 79°38'24.79"E) and is bounded on the eastern side of Mahabubnagar and major southeastern part of Nalgonda district falls in parts of the Survey of India (SOI) 1: 250,000 scale toposheets of 56L and 56P and 1:50,000 scale toposheets of 56 L6,10,14,56 P 1,2,5,6,7,8,9. The Study area covered Kalwakurthy, Devarkonda, Mallepally, Nalgonda, Miryalguda, Huzurnagar towns which are well connected with state highways to major cities. Figure 1 gives the traverse layout of magnetic observations.

Total magnetic field surveys were carried out using the IGIS P_600 Proton Precession Magnetometer with a station interval of 0.2 Km (corresponding to scale of survey of 1:50,000) along all available roads and tracks in the region. The magnetic observations were corrected for diurnal variation and referenced to the base station. The data thus obtained for subsequent analyses and interpretation is accurate to ± 5 nT.

4. QUALITATIVE INTERPRETATION

Figure 2a is the contour map of the corrected observed total magnetic intensity for the study area contoured with an interval of 10 nT. The magnetic signatures range from a low of 42444 nT along parts of the western margin of the study area near Kalwakurthy to a high of 42789 nT in the eastern part, near Nereducherla with the general trend of the contours being NW-SE. However, as the magnetic signatures are very noisy in the area, around Nidamanur, Nalgonda, Tipparti and Nereducherla areas having high magnetic intensity recorded over basic dolerite dyke and archean granites and gneisses and correlation of magnetic low areas are around Charagonda, Peddavura, Devarakonda. These lows may be evident of base metal deposits especially in Kammapalli and P.Adiracipalli areas. The basic dyke is investigated and appears to be characterized by N-S, E-W, NE-SW and NW-SE trends, observed magnetic high closures.

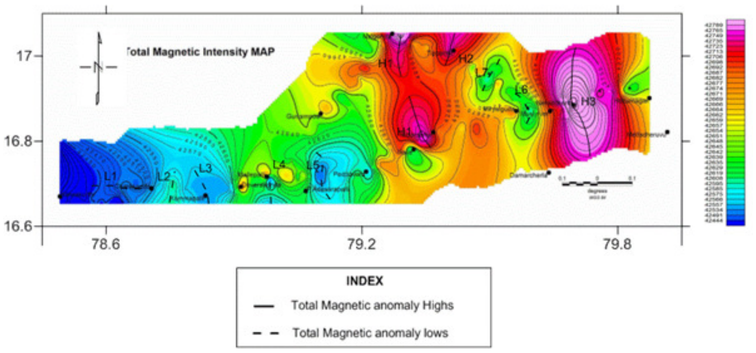


Figure 2(a) Total Magnetic Intensity contour Map of the Study area

In the case of low pass filter (cut off wavelength of 0.005 cycles/sec) was applied to it to suppress the high frequency disturbance from surface/near surface sources. Fig. 2b shows the color shaded contour map of low pass filtered total magnetic intensities in the study area. The distinct pattern of highs and lows and the steep gradients between them at places that describe prominent magnetic linears are attributable to the complex assemblage of features of varied dimensions and direction resulting from different phases of magmatic activity. Some of the features are associated with basic/ultrabasic/younger acidic intrusives that indicate zones of magneitc permeability.

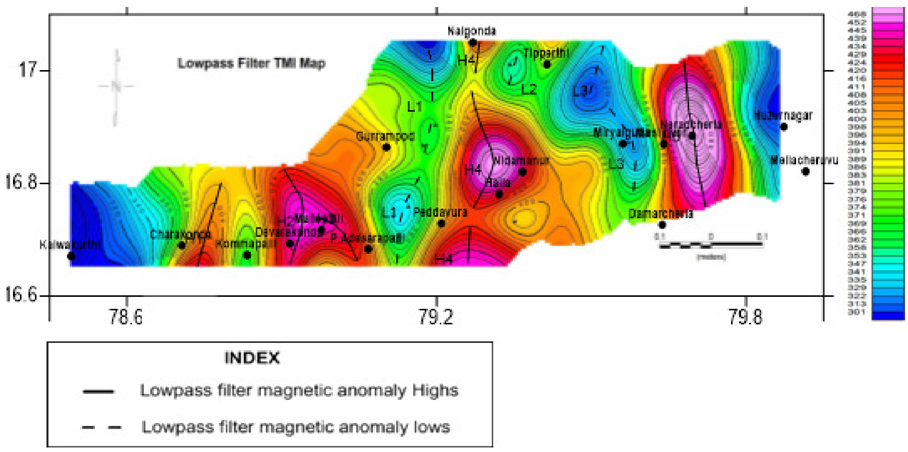


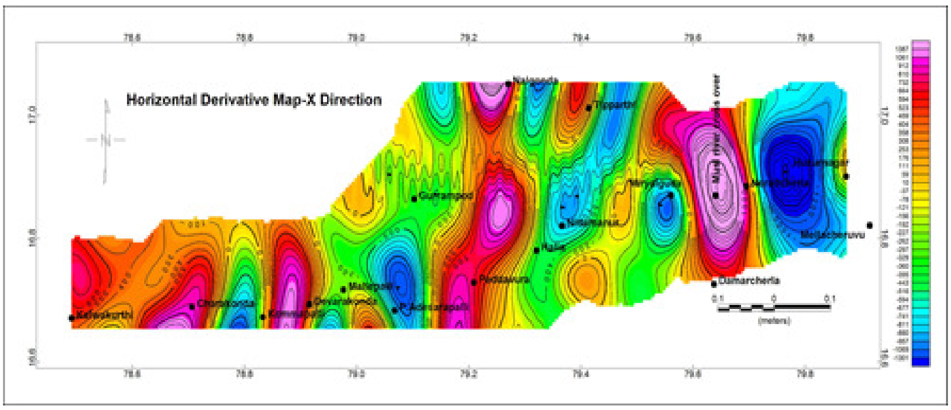
Figure 2b Low pass filter map of the study area

From a comparison of the magnetic signatures (Figure 2b) with the geology of the region (Figure 1), some broad inferences can be made: peninsular gneisses show variable response reflecting variations in their composition. While magnetic highs are recorded over intermittent occurrences of basic dykes/rocks, the younger granites and base metals register low magnetic responses. Broadly, while magnetic highs are recorded over basic dolerite dyke and the correlation of lows over fracture zones is evident. The basic dyke is investigated and appears to be characterized by N-S, E-W, NE-SW and NW-SE trends, observed magnetic high closures.

5. DERIVATIVES OF TOTAL MAGNETIC INTENSITY

In order to qualitative interpretation of magnetic data such as estimation of the structural depth to the magnetic sources, analytical techniques like horizontal, vertical derivative, analytical signal and tilt derivative techniques were used in the present analysis.

(A) Horizontal Derivative



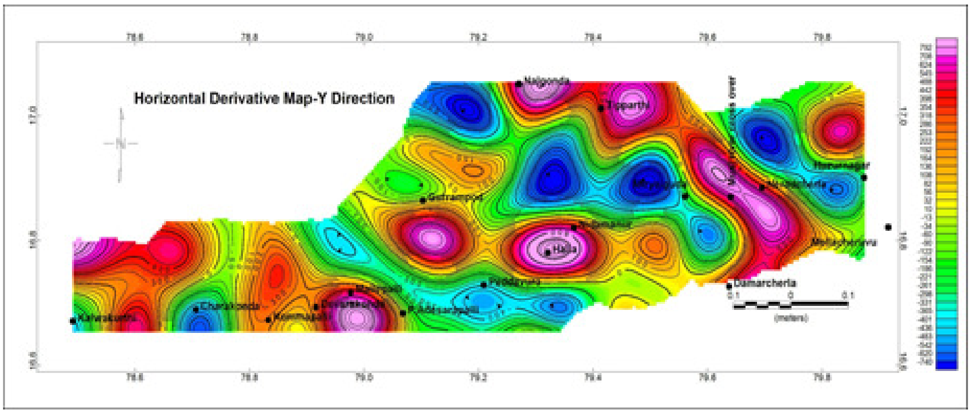


Figure 2c Horizontal derivative map of X and Y – direction of study area

Total magnetic data are often useful in defining the lateral and vertical extent and geological contacts more sharply contour maps as also give an estimate of the depth of the source body and the location and dip of its edges. Horizontal gradients of magnetic anomalies are clearly noticed over edges of tabular bodies. For near surface bodies with near-vertical contacts, the maximum horizontal gradient. This Horizontal gradient can be divided in to two directions i.e. Horizontal gradient in X-direction and Horizontal gradient in Y-direction.

(B)Vertical Derivative

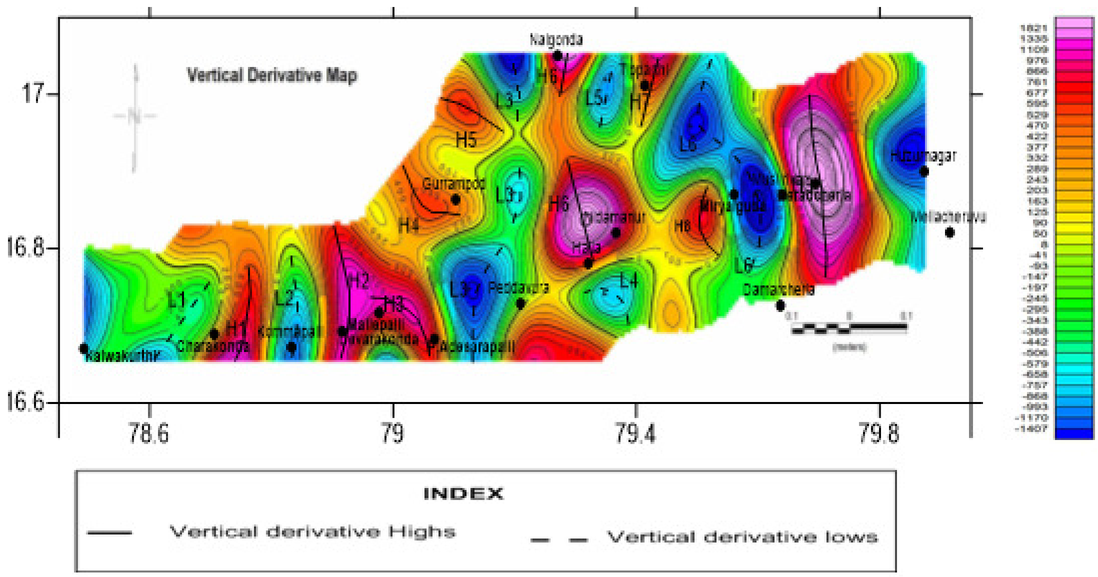


Figure 2d Vertical derivative map of the study area

A vertical derivative map enhances the response from shallow sources, suppressing deeper ones by enhancing high wave number components of the spectrum. This map is dominated by essentially NW-SE and NE-SW striking anomalies. Most of the high-frequency anomalies are evident that Gurrompod, Mallepalli, Nidamanur areas.

C) Analytical signal

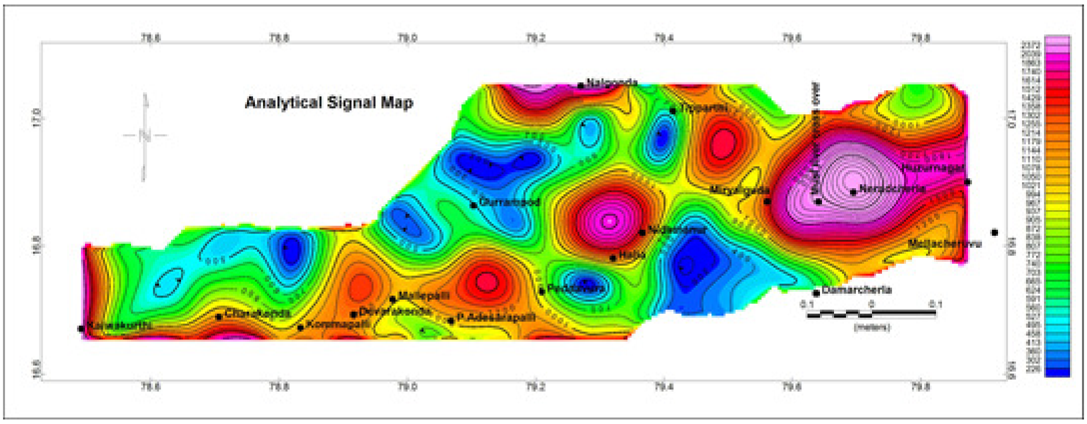
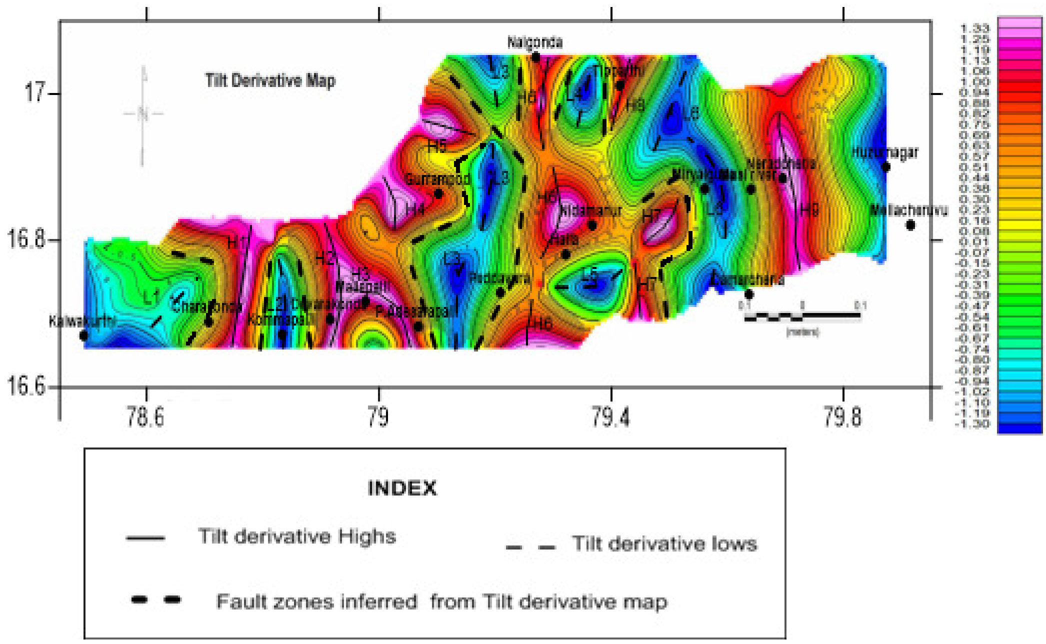


Figure 2d Analytical signal map of the study area

The analytical signal (Total gradient) figure gives finer resolutions of magnetic anomaly trends and locations and depositions of causatives (Ramadss et al 1986) the anomaly square root of the (Nabhigain, 1972) sum of squares of the horizontal(X and Y) and vertical derivaties (Z) along the orthogonal axes of the anomaly resolves the anomaly maps. It encompasses information of the magnetic field variation along the orthogonal axes completely defining it. From the analytical signal map of the magnetic in the signal shaded anomaly map of the study area is represented in the figure of study region is reflecting similar trends observed in total magnetic intensity map, which suggest that the magnetic basement occurs at shallow depth (Sri Ramulu et.al 2016).

d) Tilt Derivative

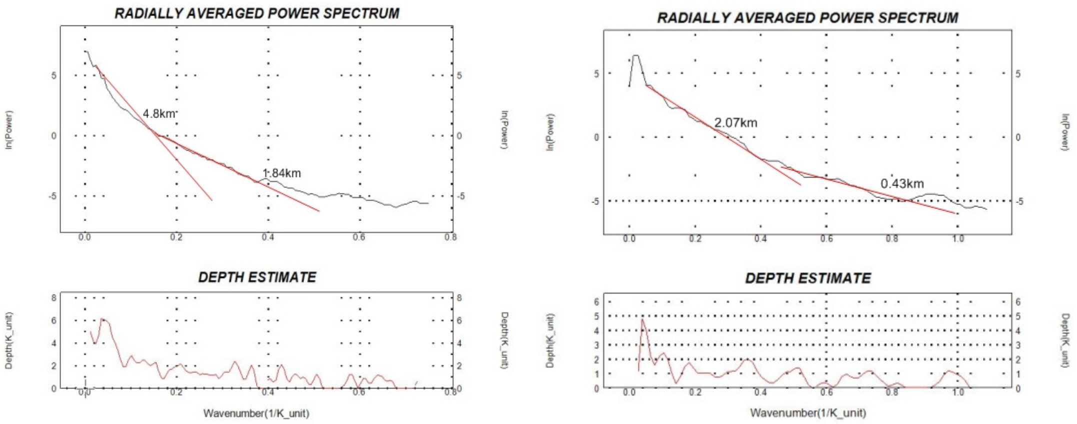


In general, the tilt derivative enhance the high frequencies relative to low frequencies and eliminates the long wavelength regional component and effectively resolves the adjacent anamolies. Miller and sing (1994) introduced the tilt angle method for one-dimensional magnetic data and Veroduzo et al (2004) extended it to two-dimensional gridded data. Orcu

and keskinsezer (2008) proved that tilt angle technique is applicable to map the linear geological features from magnetic gradient data.

7. QUANTITATIVE ANALYSIS

The process of mapping the depth to basement using of magnetic data involves calculating the average radial power spectrum (Emujakporue and Ofoha, 2015). The radially averaged power spectrum of ground/aeromagnetic data generally gives the depths of the different magnetic horizons (Spector and Grant, 1979; Naidu, 1970). The average radial (Energy) power spectrum is calculated using Fast Fourier Transform (FFT) as Log of Energy (FFT magnitude) versus radial frequency in Rad/km. A straight line is then visually fit to the energy spectrum, both in the higher and lower frequency of the figure. This windows have had their radial spectra calculated and the depths picked. The study area having deeper basement at 4.8 km and shallow basement at 1.84 km in Kalwakurthy to Huzurnagar profile and deeper layer 2.17 km and shallow layer at 0.43 km in Miryalguda to Mallepally profile.



8. DISCUSSIONS AND CONCLUSIONS

The trends (NW-SE, NE-SW and E-W) of the magnetic lineaments are deduced from the maps such as Horizontal derivative X & Y direction, Tilt, Vertical derivative and analytical signal of the magnetic anomaly. The total magnetic surveys bring out complex patterns of highs and lows magnetic interface suggest of close association with structural features such fault and fracture zones etc. The magnetic lows mostly indicate the base metals and highs indicates the dykes and Archean granites and gneisses. The average depth computed from the power spectrum analysis is 2 km, this depth may represent the depth to the magnetic basement/granite gneiss basement in the study area.

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